SUBMISSION TO

THE HOUSE OF COMMONS STANDING COMMITTEE
ON ENERGY, MINES AND RESOURCES

BY

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I. INTRODUCTION

We are very pleased to have the opportunity to appear before the Committee to contribute to your consideration of the subject of nuclear power economics.

New Brunswick derived its electrical energy in the early days from its rivers and local coal resources. Most of the hydro-electric potential in the Province has been developed for several years and local fossil fuel resources have not been sufficient or economic enough to meet the total requirement for electricity. Consequently for many years New Brunswick has been using imported oil to make up the short fall. NB Power has interties with Québec, Prince Edward Island, Nova Scotia and Maine. There are regular energy interchanges with all the adjoining utilities with major net purchases from Québec and major net sales to New England.

Because of the limited local energy resources and because of the capacity, provided by the strong interties and the total available market, to accommodate relatively large units on the system, NB Power has been interested in nuclear power for 20 years. The first unit, Point Lepreau I, was committed 15 years ago and entered commercial service 5 years ago.

This submission provides:

- background information on the NB Power system
- experience with Point Lepreau I during the construction phase and during operation, embracing technical, financial, social and economic aspects
- potential for further nuclear power in New Brunswick
- waste disposal views
- long range considerations

II. BACKGROUND

Electric Power Act

The New Brunswick Electric Power Commission, or NB Power, is a publicly-owned provincial crown corporation established in 1920 under the Electric Power Act of the Provincial Legislature:

"The intent, purpose and object of this Act is to provide for the continuous supply of energy adequate for the needs and future development of the Province and to promote economy and efficiency in the generation, distribution, supply, sale and use of power."

NB Power Goals and Objectives

NB Power's goals are two-fold:

To provide a safe, reliable and adequate supply of electricity to New Brunswick customers at the lowest practicable cost.

AND

To use the opportunities provided by the development and operation of the NB Power system to enhance the economic development of the Province of New Brunswick.

In meeting these long-term goals, NB Power's current objectives are to:

- stabilize production costs
- make economic use of indigenous fuel resources
- maintain market share for exports
- reduce oil dependence
- promote the wise use of electricity
- optimize its long-term financial structure

Generation Capacity

NB Power's generating capacity consists of:

hydro	865	MW
nuclear	635	MW
oil	1425	MW
coal	265	MW
for a total of	3190	Megawatts

Hydro potential in New Brunswick is largely developed. The Saint John River has limited storage capacity and hydro production is basically determined by the 'run of the river'. Flows vary considerably throughout the year. Other than during the high flow spring and fall periods, hydro is used primarily for meeting peak loads.

Nuclear power is provided by a single CANDU 600 unit at Point Lepreau. Approximately 2/3 of the output is utilized in New Brunswick. Several New England utilities - Boston Edison, Massachusetts Municipal Wholesale Electric Company, Commonwealth Electric and Eastern Maine Electric Co-operative, have unit participation contracts in Point Lepreau totaling 230 MW.

NB Power is planning to convert its largest oil-fired plant at Coleson Cove to coal or to Orimulsion - an emulsified bitumen product. Presently, No. 6 oil is shipped to Saint John, pumped off tankers into storage and transported by pipeline 27 km to Coleson Cove. Oil supply is tendered and in recent years has been bought directly from Venezuela.

NB Power's coal plants at Grand Lake and Dalhousie are fired with a local coal strip-mined in the Minto area. It is a very high sulphur coal and major R&D work is progressing at our Chatham plant on sulphur dioxide reduction. Recently, a 22 MW Circulating Fluidized Bed test facility was commissioned at Chatham. In addition to testing high sulphur New Brunswick coal in conjunction with oil shale and limestone, the unit is available to fuel suppliers and electric utilities for combustion trials on a variety of low-grade fuels.

Transmission System

NB Power has 6 160 km of transmission lines. The utility serves 53 customers directly off the transmission system. These customers consume 50% of the provincial total - 51 of these customers, in fact, account for 42% of total kW.h sales.

The remaining 2 customers off the transmission system are wholesale customers (cities of Saint John and Edmundston which account for 8% of kW.h sold).

Interconnection System

NB Power's transmission system interconnects with all other utilities in neighbouring provinces and states.

Interconnection capacity is as follows:

Nova Scotia	400 MW
P.E.I.	100 MW
Hydro-Quebec	1,000 MW
New England	700 MW
Maine	110 MW

The largest of our interconnections is with Hydro-Quebec. Because we are also connected to the large New England system, we need high voltage direct current (HVDC) stations between ourselves and Quebec to maintain the integrity of our system.

In-Province Supply

In-province energy sales of 10.3 billion kilowatt hours (kW.h) for the fiscal year 1986/87 was supplied as follows:

follows:	29.7%	by nuclear
	23.3%	by hydro
	14.5%	by oil
	4.8%	by coal
	27.7%	by purchased power as a replacement for oil and coal

Each year, NB Power purchases surplus energy most of which comes from Hydro-Quebec. This energy is purchased on an hourly basis and costs 80% of what it would cost NB Power to generate. In 1986/87, the utility purchased 6.7 billion kW.h.

Total Supply

NB Power not only supplies in-province customers, but export customers as well. When the utility has surplus energy - for example in the spring when river flows are high - NB Power sells surplus on an hourly basis. NB Power also has firm sales, i.e. contracts to supply a certain amount of energy to a certain utility for a certain period of time. These contracted sales are principally from Point Lepreau.

Export sales during 1986/87 totalled 6.9 billion kW.h bringing total sales for the year to 17.2 billion kW.h.

Benefits from Interconnections

Benefits from the purchase and sale of surplus energy over our interconnections has meant that in-province rates have been 14.3% lower than otherwise on average over the last ten years.

Rate Comparison

Electricity rate increases in New Brunswick have been below the rate of inflation in the 1980's. Rates in New Brunswick are much lower than eastern U.S. rates and are the lowest in Atlantic Canada. They compare favourably with other Canadian provinces except those with large hydro resources.

Financial Position

For fiscal year ending March 31, 1987

	($ Millions)
Total Revenue	$825.2
Expenditures	812.9
Net Income	29.3
Total Fixed Assets	$3,035
Long-Term Debt-Net	$2,088

NB Power's debt/equity ratio has been improving in recent years and currently stands at 84/16.

III. EXPERIENCE WITH POINT LEPREAU I

Experience with Point Lepreau I has two phases: the construction phase and the operational phase. The construction phase can be regarded as having lasted from the first steps toward commitment in 1973 to commencement of commercial operation in 1983. The operational phase overlaps the construction phase and can be regarded as beginning with the commencement of creation of the operating staff (1974) and extending to the present day.

3.1 CONSTRUCTION PHASE

Organization

Atomic Energy of Canada Limited (AECL) performed the engineering of the nuclear (the steam raising) portion of the plant. NB Power assumed responsibility for engineering of the rest of the plant engaging consultants as necessary to assist in this function.

NB Power purchased most of the necessary equipment and supplies directly from the suppliers on the recommendations of AECL and the consultants. An exception was certain major, special equipment which, for reasons of standardization, AECL bought for several projects and resold to each of the plant owners (NB Power, Hydro-Québec, Commision de Energia Nuclear de Argentina, Korea Electric Power Co.).

NB Power acted both as project managers and construction managers but all construction work at site was carried out using construction contractors.

The completed systems and, eventually, the whole station were commissioned by NB Power's operating staff to the specifications and with the advice and assistance of AECL, NB Power's own engineers, and the consultants.

Financing

The Government of Canada, through AECL, loaned NB Power $350 million (half the original estimated cost of the station) at the then current federal crown company borrowing rate.

All other financing was obtained by NB Power through its normal channels for borrowing money.

Performance

It took 8 years to build the plant instead of the originally scheduled 6 years. The final cost was $1.45 billion or twice the original estimate.

The plant, however, is clearly a good one and the schedule protraction and cost overruns were by no means exceptional in that period of high construction activity and very high inflation. Indeed, they were well below most contemporary experience in the United States.

Nevertheless, the technical problems, institutional problems, some organizational frustrations, the schedule extension, and the expanding funding requirements put more strain on senior and middle management than was anticipated. It is something that others who might be in a similar position should be prepared for.

3.2 OPERATIONAL PHASE

NB Power began assembling operating staff in 1974. The Station Manager joined in 1975. Despite this early start and a vigorous and very conscientious program, acquisition and training of the staff and their qualification to Atomic Energy Control Board requirements was not completed until shortly before plant operation began in 1982.

Commissioning of systems began in 1979; the reactor was first started up in July 1982; electrical power was first produced in September; and the station was declared in service on February 1, 1983. Again, despite technical and institutional problems, the station was successfully commissioned in very good time.

Since entering commercial service the station has had an exceptional operating record. Total production to date exceeds 27 billion kW.h. To have produced this amount of electricity from oil would have required over 42 million barrels of fuel oil costing over $1.1 billion. Its average capacity factor, or percent of maximum possible production, in its first 5 years of commercial operation has been over 92 per cent, one of the highest in the world for that period among more than 300 power reactors.

Operating Objectives

The objective in operating the station is to generate maximum practicable electricity safely, reliably, and economically with essentially no adverse effects on the environment. The preceding paragraph addresses experience with regard to reliability. Other important operating statistics are as follows.

Safety and Cleanliness

- The accident frequency rate at Point Lepreau is 7.6, about 1/3 that of other thermal plants on the NB Power system. Accident frequency rate is defined as Number of Disability Injuries x 10^6/hours worked.
- The average radiation dose for station personnel has been between 1 and 2 millisieverts (msv) per person per year. Peak individual doses in 1986 and 1987 have been 16.7 msv and 15.7 msv. The regulatory limit is 50 msv per year.
- There has been no radiation dose to members of the public. The calculated theoretical maximum dose has been less than 0.02 per cent of the regulatory limit.
- Annual releases of radioactivity in liquids have been less than 0.001 per cent of the regulatory limit.
- Annual releases of radioactivity in gases have been less than 0.02 per cent of the regulatory limit.

As evidenced by these statistics the station has been operated very safely and cleanly.

Economy

Table I shows the total unit energy cost at Point Lepreau for the fiscal years 1983/84 to 1986/87 in comparison with those for other thermal power plants on the NB Power system adjusted for capacity factor, and for the actual capacity factor.

TABLE I

TOTAL UNIT ENERGY COST (CENTS/kW.h)

	Pt. Lepreau 1-635 MW (N)	Coleson Cove 3-335 MW (Oil) Estimated at 80% Cap. Factor (At Actual Cap. Factor)		Dalhousie 1-200 MW(Coal) Estimated at 80% Cap. Factor (At Actual Cap. Factor)	
1983/84	5.0	5.1	(6.9)	3.8	(5.5)
1984/85	5.4	5.6	(7.1)	4.1	(5.9)
1985/86	5.3	6.0	(8.1)	4.0	(5.8)
1986/87	5.4	3.5	(4.7)	4.3	(6.4)

NOTES:

1. The unit energy costs for Coleson Cove and Dalhousie at 80 percent capacity factor were estimated by pro-rating the fuel costs only for the higher-than-actual capacity factor.

2. The use of low sulphur oil would increase Coleson Cove total unit energy cost at 80% capacity factor by about 0.4 cents/kW.h.

3. The use of scrubbers would increase Dalhousie total unit energy cost by about 0.7 cents/kW.h.

As can be seen from the Table and the notes, Point Lepreau I compared very favorably with Coleson Cove when oil prices were high but is at a disadvantage at recent price levels. Its total unit energy cost is somewhat higher than that of the coal-fired station with an adjusted capacity factor even if it is assumed that flue gas desulphurization is applied, but lower than actual costs.

In extrapolating to the future, it must be borne in mind that New Brunswick coal is limited and imported coal prices are relatively low at the present time. It is clear that the Point Lepreau No. 1 unit has a lower total cost than any alternate plant which could be brought on line today.

Export

A very important aspect of the Point Lepreau project is export of one-third of its output to New England. This is done under "all events" cost-of-service contracts with several utilities in that area. Under these contracts the buyers pay all fixed charges, including their share of provisions for eventual plant decommissioning and fuel waste management, for their share of the unit's capacity regardless of how much or how little energy they receive and they pay appropriate shares of all variable costs for the energy they receive. These contracts extend to October 1988 with provision for annual extensions to 1991.

These contracts do two important things for NB Power. First, the effect of the outright sale of 230 MW capacity of the plant means that it is effectively a 405 MW unit on the NB Power system. The relevant reserve provision corresponds to this lower figure.

Secondly, of course, the system's customers benefit from the economies of a 635 MW unit although there is effectively only 405 MW of nuclear capacity on the system.

These export sales made the project financially tractable in the face of the higher than anticipated capital cost.

From a national point of view it is worth noting that export sales of this type are tantamount to selling a nuclear power plant of that capacity (230 MW) plus its fuel and operation to the United States with all the benefits of exporting high tech employment and a little more uranium and of improving the balance of trade.

IV. POTENTIAL FOR FURTHER NUCLEAR POWER

NB Power has a requirement for more generating capacity in the 1990's. Units 200 to 400 MW in capacity are of appropriate size.

A 200 MW unit to use New Brunswick coal is under consideration, but there are serious cost problems because of the high sulphur content (6-8%) of New Brunswick coal and the new federal-provincial agreed limitations on sulphur emissions. The capital and operating costs for sulphur removal equipment create serious penalties on top of the steep coal recovery costs. These added costs may be balanced by social benefits and long term fuel security. It is expected that it will be committed in a thermal program which will include an initial 400 MW unit designed to burn low sulphur imported coal or bitumen product.

A nuclear unit would be an acceptable alternative to a coal-fired unit from the technical point of view. The system would be able to offer such a unit high capacity factor operation. A duplicate of the existing 600 MW Point Lepreau unit would be ideal if there were an opportunity to make a firm sale of 200 MW capacity to New England. It is recognized that there would almost certainly be divergencies from the Point Lepreau I design and no firm export market for some of the units' capacity has, as yet, been found. AECL has produced a preliminary design of a 400 MW unit which better matches the in-province requirement. This design, however, has some new features which have not yet been proven in operation. Nevertheless, the question with respect to a nuclear unit is not a technical one; it is an economic one.

A nuclear power unit entails an initial investment that is more than twice as great as that for a coal-fired unit (in round numbers, an extra billion dollars). While it is anticipated that fuel costs will alter in the future so as to render such an investment a sound one, because of its existing high relative investment in nuclear, NB Power has taken the position that the financial and economic risk for an additional nuclear unit must be no greater than for a coal-fired unit.

The scope and nature of employment associated with a nuclear power plant, during construction and operation, and the minimal environmental effects of the plant are attractive to NB Power. From the national viewpoint, installation of a nuclear power plant instead of a coal-fired plant burning imported fuel substitutes domestic high-tech employment and uranium supply for foreign coal-mining. If the federal government were to consider this employment effect sufficiently important to warrant investing the difference between the capital cost of a nuclear power plant and the capital cost of an equivalent coal-fired plant and were prepared to absorb (with the corresponding opportunity to obtain some benefit from) any difference in eventual cost between the nuclear and coal options, NB Power could give very serious consideration to the nuclear option.

V. WASTE DISPOSAL

The use of nuclear power entails producing and confining radioactive species. It entails doing this in a hot, high pressure system. It also entails the later confinement of these species, rapidly decreasing in radioactivity, in pools and other facilities at ambient conditions. Following these two stages, it will be necessary to confine these, considerably tamer, materials for about 5 centuries and advantageous to do so for as long as practicable.

Clearly, the most hazardous period is when the radioactivity is highest and is in a hot, pressurized system. The next most hazardous period is when the material is first removed from the reactor. 90 percent of the activity decays in the first year and 70 percent of the remainder in the next 10, so that after 10 years, only 3 percent of the original radioactivity remains. The utility looks after this radioactive material during these most hazardous stages. Needless to say, it is treated with due respect; but there is every confidence that it can be managed properly.

Having regard for the amount of plant and personnel required to manage the material during this highly radioactive period and the level of radioactivity at the end of the period, the subsequent custody appears quite tractable.

The subsequent custody can be broken into two periods - the first 500 years when the long-lived fission products are decaying away to 1/10,000th their original level and after 500 years when the heavy trans-uranic elements are the main toxic constituents.

After 10 years, the spent fuel (or the wastes extracted from them) need practically no cooling and it is feasible to store them in many simple ways, including concrete canisters with walls about 2 feet thick. There surely cannot be any question that, with today's technology and the evidence of many structures and artifacts that have endured from earlier times, that containers can be built and protected to last several hundred years.

With respect to the heavy, trans-uranic elements their total toxicity, even with large nuclear power programs, is small in relation to other long-lived toxicity being introduced into the biosphere routinely and extremely small in relation to total toxicity extant in the biosphere today. The nature of nuclear power process is that wastes remain in place, unlike most wastes such as automobile exhaust fumes for instance, so it is feasible and very economic to retain and confine them. The nuclear industry world-wide proposes extremely secure ways of doing this such as incorporating them in glass and impounding them in stable rock formations. Any release to the biosphere will be minuscule in comparison with the much larger amounts of toxicity now released directly into the biosphere. Unfortunately, this very careful approach has diverted attention from the fundamental question of relative safety to a discussion of the degree of perfection of the approach. It is reasonable to expect that the situation will be properly understood in time.

It does appear that the concrete-cannister concept of on-site storage at the plant site, already being utilized at the decommissioned Douglas Point and Gentilly #1 reactors, could provide low cost, safe and effective storage of spent fuel at the plant where it was used for as long as necessary.

VI. LONG TERM OUTLOOK

6.1 The World Situation

Solar energy provides man's food and nearly all the energy required for a habitable environment. For a million years wood and straw have been used for supplementary heating and for cooking. For thousands of years animal dung and fat have also been used for these purposes and for lighting; and animal power, for work and transportation. For most of the world's people biomass is still the primary source of controlled energy supply. The use of biomass for energy production remains universal, however, and is rather evenly distributed - North America and Tropic Africa, for instance, with roughly the same population, derive about the same amount of energy from biomass.

The difference between the industrialized societies and the most primitive is that the former use stored energy resources (the non-renewables) to produce 10 times as much energy as they derive from biomass. This is used for traditional purposes plus mobility and a small, but increasingly important, amount for information handling. Total world primary energy supply is approximately 300 GJ from the following sources:

Oil	40%
Coal	25%
Gas	15%
Hydro	5%
Nuclear	5%
Biomass	10%

The use of energy will probably increase as the world population increases (to about 8 billion by 2020) and energy use in less-developed areas grows.

Conventional oil production rates are predicted to decline in a very few decades; gas production in a few more. Tar sands and oil shales will extend the supply of the naturally fluid hydrocarbons for a while. Hydro potential is about 4 times that already developed but it is largely in areas in Africa and Asia that cannot soon afford the large investments needed to develop it. Energy production from biomass can be expanded moderately. Other renewable resources offer very little economic energy for the foreseeable future.

The main energy sources to succeed oil and gas as major supplies are coal and nuclear energy. Coal production can provide amounts of energy comparable to those from oil and gas for several decades. Uranium can provide at least 10 times as much energy as all the fossil fuels.

The expectation therefore is that coal and nuclear power will become the main sources of electrical energy in the next century.

6.2 <u>New Brunswick</u>

It is expected that, in common with the world in general, New Brunswick will generate much of its electricity from coal and uranium in the 21st century. Other sources will not be overlooked but the backbone of electricity supply is expected to be coal and nuclear power.

New Brunswick is well-positioned for this:

1. Because of its maritime location it has ready access to world fossil fuel supplies.
2. Because it is part of a technically well-developed and a relatively wealthy society it has ready access to the necessary technology and industry for modern electricity generation and transmission and it has the internal competence to use it.
3. Because of its experience with oil-fired, coal-fired, hydro electric and nuclear power plants NB Power has the internal capability to properly evaluate options and to commit, construct and operate the most appropriate facilities.

NB Power does not and cannot have all the technical support necessary to utilize nuclear power plants. As a member of the international CANDU Operators Group (COG) it can obtain invaluable support from other members and contribute to the growing body of knowledge of CANDU plants. Since these plants are significantly different from other nuclear power plants it is absolutely essential, however, that, if the line is to survive and improve, that there be a strong research and engineering effort devoted to maintaining it. In the past this has been provided by the federal government through AECL. It is appropriate that the utilities and industry assume a larger share of these efforts as the family of CANDU plants expands and this has, indeed, been happening. However, a major fraction of the research and specific engineering needs to continue to be provided by the federal government for as far as we can see. An alternative, of course, would be to abandon the CANDU line for light water reactors and to rely on foreign research and specific engineering as we, in this country, do in some other industries.